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Application of Kazuo Morita

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For ROTARY PUMP

Attorney's Docket 0673-119P/GPK

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PATENT TRADEMARK OFFICE

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Hon. Commissioner of Patents and Trademarks
Washington DC 20231

Sir:

NEW PATENT APPLICATION

Enclosed herewith for filing is a 20 page application comprised of an abstract, specification, 20 claims, 10 sheets of drawings consisting of Figs. 1-11, a declaration, claim for small entity status, and a check in the amount of $345.00 covering the filing fee.

The priorities of Japanese Patent Applications Nos. H11-101634, H11-101635, and H11-101636, each filed on August 4, 1999, are hereby claimed, the contents of which are incorporated herein by reference thereto. Certified copies will be filed in due course.

Also enclosed is an assignment together with its cover sheet and a check in the amount of $40.00 for the recording fee. Please record the assignment and return the recorded assignment to the undersigned.

The Commissioner is hereby authorized to charge in the future any fee deficiency which is indispensable to obtain a filing date, or to maintain the pendency of the application, to our deposit account No. 19-0748.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Attorney's Docket 673-

Applicant of Patentee:

Serial or Patent No.:

Filed or issued:

For:

CLAIM FOR SMALL ENTITY STATUS

I hereby declare that I am an official empowered to act on behalf of the following *small business concern*:

Name of small business: NAKAKIN CO., LTD.

Address: 1-21, Kikawahigashi 4-chome, Yodogawa-ku, Osaka-shi, Osaka, Japan

It is hereby certified that the total number of full- and part-time employees of the above-identified small business, including those of any of its affiliates, has not exceeded 500 during the past year and does not exceed that number within the preceding 12 months.

It is hereby declared that the rights in and to the above-identified application have not been assigned or licensed, and that there exists no obligation to license or to assign such rights to any organization that, together with any and all of its affiliates, had more than 500 full- and part-time employees within the last 12 months.

The duty is acknowledged in this application or patent, to notify any change in status resulting in loss of entitlement to small entity status at specified times during the pendency of application and lifetime of any patent thereon.

I hereby declare that all statements made herein of my own knowledge are true and that all statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this declaration applies.

Date: March 20, 2000 , 199

Shuji Enomoto

Name: Shuji Enomoto

Title: President

ROTARY PUMP

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a rotary pump suitable for transporting liquid foods.

Description of the Related Art

In a rotary pump of the type set forth above, the recent prior art has been disclosed in commonly owned U. S. Patent No. 5,370,514, issued to Morita et al.

Since the present invention has some common structures with the above-identified commonly owned prior art, the construction of the prior art will be discussed hereinafter in detail in order to facilitate clear understanding of the present invention.

Figs. 10 and 11 show the commonly owned prior art. In these drawings, the reference numerals 1A and 1B denotes rotors. From each of rotors 1A and 1B, a short rotor shaft 2 is provided from the central portion of one end surface thereof. A threaded bore 3 is coaxially formed from the end surface of the rotor shaft 2. A pumping segment 4 is integrally formed on the outer peripheral portion of each rotor 1A and 1B.

The reference numeral 6 denotes a pump casing. The pump casing 6 includes a main casing defining a concave pumping chamber 7 loosely accommodating the pumping segments 4 or revolution therein and formed with a suction port 8 and a discharge port 9, and a casing cover 11 detachably attached on the main casing 10 flush with the end surface of each rotor 1A and 1B by means of bolts and nuts.

The reference numeral 12A and 12B denote hollow rotor drive shafts provided corresponding to the rotors 1A and 1B. The rotor drive shaft is supported by means of a bearing 14 within a gearbox 13 for the drive shaft for rotation and restricting movement in an axial direction. The reference numeral 15 denotes a rotor fastening bolt inserted through a hollow portion of each of the hollow rotor drive shafts 12A and 12B from one end to the other end. A bolt head 15a of the rotor fastening bolt 15 is engaged with one end surface rotor drive shaft 15.

A hollow portion 16a at the tip end of each rotor drive shaft 12A and 12B is externally engaged with the rotor shaft 2 of each rotor 1A and 1B. In conjunction therewith, a threaded portion 15b at the tip end of the rotor fastening bolt 15 is threadingly engaged with the threaded bore 3 of the rotor shaft 2.

In Fig. 11, the reference numeral 17 denotes a gearbox for a transmission shaft. A transmission shaft 21 is rotatably supported via bearings 18 and 19 within the gearbox 17, and is connected to a motor (not show). A gear 22 is mounted on the transmission shaft 21. In the gearbox 13 for drive shaft, gears 23a and 23b for transmitting rotation for driving a pair of rotor drive shafts 12A and 12B in mutually opposite direction in synchronism with each other and a gear 23c meshing with the gear 22 mounted on the transmission shaft 21 are provided. Accordingly, a driving force of the motor

to be transmitted to the transmission shaft 21 is transmitted to one rotor shaft 12A via the gears 22 and 23c. The driving force of the rotor drive shaft 12A is transmitted to the other rotor drive shaft 12B via the gears 23a and 23b.

For assembling the rotary pump constructed as set forth above, the pumping segment 4 of each rotor 1A and 1B is received within the pumping chamber 7 of the main casing 10. In conjunction therewith, each rotor shaft 2 is engaged with the hollow portion 16a at the tip end of the hollow rotor drive shaft 12 supported within the gearbox 13. Then, the rotor fastening bolt 15 is inserted within the rotor drive shaft 12 from one end to threadingly engage the threaded portion 15b at the tip end thereof with the threaded bore 3 of the rotor shaft 2. Then, the bolt head 15a is rotated by a rotary tool, such as spanner or the like for tightening to draw each rotor 1A and 1B toward the rotor drive shaft 12 for fixedly fastening.

In the rotary pump assembled as set forth above, a rotational torque of the not shown motor is transmitted to the transmission shaft 21. Both of the rotor drive shafts 12 driven to rotate via the transmission shaft 21 drive to rotate both rotors 1A and 1B in mutually opposite directions in synchronism with respect to each other as shown by arrows in Fig. 11. Thus, by action of the pumping segments 4 rotated within the pumping chambers 7, liquid is sucked into the pumping chamber 7 through the suction port 8 and is pressurized and fed to the discharge port 9. In this case, overall inner side surface of the casing cover 11 is a flat surface forming in flush with the external end surface of the rotors 1A and 1B so as not to form recessed portion between the rotors 1A and 1B. Therefore, retention of the transported liquid flowing through the pumping chamber 7 will never be caused. Accordingly, washing of the pumping chamber can be easily performed.

On the other hand, upon disassembling the rotors 1A and 1B, the nuts 20 are loosen to remove the casing cover 11, and thereafter, the rotors 1A and 1B are disassembled easily by simply loosening the rotor fastening bolts 15.

As can be clear from the construction, in the prior art, the gearbox 16 for the transmission shaft 21 is provided separately from the gearbox 13 of the drive shaft, and driving force has to be transmitted to the rotor drive shaft 12 via the gear mounted on the transmission shaft 21 on the side of the motor and the gear 23a housed within the gearbox 13 for the drive shaft.

Conventionally, in addition to a pair of rotor drive shafts 12A and 12B for driving the rotor as set forth above, the transmission shaft 21 for transmitting the rotational torque of the motor to the rotor drive shafts 12A and 12B, and thus at least three shaft in total are required. Therefore, the construction is inherently complicate.

On the other hand, as can be clear from the construction set forth above, in the recent prior art, the rotor fastening bolt 15 inserted into the hollow portion of the hollow rotor drive shaft 12 is rotated by rotating the bolt head 15 at the rear end portion with the rotary tool in the condition where the threaded portion 15b at the tip end is threadingly engaged with the rotor 1A (1B) to draw the rotor 1A backward by the rotor fastening bolt 15 and to abut the bolt head 15a onto the end surface of the hollow rotor drive shaft 12. On the other hand, upon disassembling, the rotors 1A and 1B can be disassembled easily only by

loosening the rotor fastening bolt 15 by rotatingly operating the bolt head 15a. Also, the mating surfaces of the rotor 1A(1B) and opposing casing cover 11 may be formed in flush. Coupling between the rotor 1A(1B) and the hollow rotor drive shaft 12A(12B) is effected by externally engaging the tip end portion of the drive shaft and by maintaining external engagement by drawing force applied by tightening the rotor fastening bolt 15 into the rotor shaft 12. Therefore, connection force therebetween is insufficient. Also, centering of the rotor 1A(1B) and the hollow rotor drive shaft 12A(12B) cannot be complete to possibly cause center vibration.

Furthermore, as shown in Figs. 10 and 11, the conventionally rotary pump defines the pumping chamber 7 with the main casing 10 and the casing cover 11 mounted thereon. A pair of rotors 1A and 1B are housed within the pumping chamber 7. The end surface 1a of the casing cover 11 of each of rotors 1A and 1B are placed in substantially contacting state with a minimum fine gap required for permitting rotation of the rotor 1A and 1B. Both rotors 1A and 1B are synchronously rotated in mutually opposite directions by mutually engaging the pumping segments 4 of the rotors 1A and 1B by the rotor drive shafts 12 as shown by the arrows of Fig. 11. Thus, the liquid is sucked into the pumping chamber 7 through the suction port 8, and pressurized and fed to the discharge port 9. In this case, a gap between the end surface 1a of each rotor 1A and 1B and the inner end surface 11a of the casing cover 11 mating thereto is substantially contacting state with minimum fine gap for permitting rotation of the rotor 1A and 1B. Flow ability of the liquid in this fine gap is quite low. Accordingly, even when the washing liquid is circulated within the pumping chamber at the end of work in one day, the washing liquid does not flow sufficiently between both end surfaces 11a and 1a. Therefore, sufficient washing effect cannot be achieved.

SUMMARY OF THE INVENTION

The present invention has been worked out in view of the problems set forth above. Therefore, it is the first object of the present invention to construct a rotary pump with simple construction by omitting a transmission shaft on the side of a motor and whereby to make a cost of the rotary pump as low as possible, with maintaining feature that assembling and disassembling is facilitated.

The second objection of the present invention is to enhance fastening force between the rotary drive shaft and the rotor and assure centering therebetween so as not to cause center vibration even by long term use.

The third object of the present invention is to achieve satisfactory washing effect by flowing sufficient amount of washing liquid through a gap between an end surface of a rotor and an inner end surface of a casing cover opposing thereto.

According to the first aspect of the present invention,a rotary pump comprises:

a pair of rotors having pumping segments mutually engaged with each other for synchronous revolution in mutually opposite direction within a pump casing;

a pair of hollowing rotor drive shafts supported in gearboxes adjacent

the pump casing for integrally rotate with a pair of the rotors; and

a pair of rotor fastening bolts inserted into hollow portions of respective hollow rotor drive shafts to fix the pair of rotors and the pair of hollow rotor drive shafts on the outer end surfaces of the rotor drive shaft under tension,

respective of the hollow rotor drive shafts being synchronously rotated in mutually opposite direction with meshing with synchronous driving gears provided in respective gearboxes,

among both of the hollow rotor drive shafts, one of the hollow rotor drive shaft extends outwardly from the gearbox to form an extended drive shaft portion, a cylindrical frame form transmission coupling having an operation space for operating the rotor fastening bolt being coupled with the extended drive shaft portion for integral rotation.

According to the second aspect of the present invention a rotary pump comprises:

a pair of rotors having pumping segments mutually engaged with each other for synchronous revolution in mutually opposite direction within a pump casing;

a pair of hollowing rotor drive shafts supported in gearboxes adjacent the pump casing for integrally rotate with a pair of the rotors; and

a pair of rotor fastening bolts inserted into hollow portions of respective hollow rotor drive shafts to fix the pair of rotors and the pair of hollow rotor drive shafts on the outer end surfaces of the rotor drive shaft under tension,

respective of the hollow rotor drive shafts being synchronously rotated in mutually opposite direction with meshing with synchronous driving gears provided in respective gearboxes,

the rotors and the hollow rotor drive shafts being connected by spline couplings for integral rotation,

the rotor fastening bolts being inserted through the hollow rotor drive shafts through the rotors from the side of the casing cover, and

a flange provided on a end portion of the rotor fastening bolt being engaged within a recessed portion on the end surface of the rotor on the side of the casing cover.

According to the third aspect of the present invention, a rotary pump comprises:

a pair of rotors having pumping segments mutually engaged with each other for synchronous revolution in mutually opposite direction within a pump casing;

a pair of hollowing rotor drive shafts supported in gearboxes adjacent the pump casing for integrally rotate with a pair of the rotors; and

a pair of rotor fastening bolts inserted into hollow portions of respective hollow rotor drive shafts to fix the pair of rotors and the pair of hollow rotor drive shafts on the outer end surfaces of the rotor drive shaft under tension,

respective of the hollow rotor drive shafts being synchronously rotated in mutually opposite direction with meshing with synchronous driving gears

provided in respective gearboxes,

the rotor and the hollow rotor drive shaft being connected by spline coupling for integral rotation,

the rotor fastening bolts being integrally formed with the rotors, and

the rotor fastening bolts being inserted into the hollow rotor driven shafts.

According to the fourth aspect of the present invention, a rotary pump comprises:

a main casing;

a casing cover cooperated with the main casing for defining a pumping chamber therebetween;

a pair of rotors received within the pumping chamber with mutually meshing pumping segments for synchronous revolution in mutually opposite directions;

a space being defined in one portion of the casing cover;

a cover piston being disposed within the space for movement back and forth with respect to an end surface of the rotor;

an air cylinder being mounted on the casing cover and having a piston rod, to which the cover piston is connected.

According to the fifth aspect of the present invention, a rotary pump comprises:

a main casing;

a casing cover cooperated with the main casing for defining a pumping chamber therebetween;

a pair of rotors received within the pumping chamber with mutually meshing pumping segments for synchronous revolution in mutually opposite directions;

a space being defined in one portion of the casing cover;

a cover piston being disposed within the space for movement back and forth with respect to an end surface of the rotor;

a lock cylinder having a lock bolt being mounted on the casing cover for restricting movement of the cover piston by means of the lock bolt.

According to the fifth aspect of the present invention, a rotary pump comprises:

a main casing;

a casing cover cooperated with the main casing for defining a pumping chamber therebetween;

a pair of rotors received within the pumping chamber with mutually meshing pumping segments for synchronous revolution in mutually opposite directions;

a space being defined in one portion of the casing cover;

a cover piston being disposed within the space for movement back and forth with respect to an end surface of the rotor;

an air cylinder being mounted on the casing cover and having a piston rod;

a lock cylinder having a lock bolt being mounted on the air cylinder;

the cover piston being connected to a piston rod projected from one end

surface of the piston of the air cylinder;

a piston rod projecting from the other end surface of the piston of the air cylinder being abutted to the lock bolt for restricting movement of the cover piston by means of the lock bolt.

According to the sixth aspect of the present invention, a rotary pump comprises:

a main casing;

a casing cover cooperated with the main casing for defining a pumping chamber therebetween;

a pair of rotors received within the pumping chamber with mutually meshing pumping segments for synchronous revolution in mutually opposite directions;

a space being defined in one portion of the casing cover;

a cover piston being disposed within the space for movement back and forth with respect to an end surface of the rotor;

a plurality of air cylinders being mounted on the casing cover in a condition where piston rods thereof are connected with each other, and the cover piston is connected to a piston rod.

and having a piston rod, to which the cover piston is connected.

According to the seventh aspect of the present invention, a rotary pump comprises:

a main casing;

a casing cover cooperated with the main casing for defining a pumping chamber therebetween;

a pair of rotors received within the pumping chamber with mutually meshing pumping segments for synchronous revolution in mutually opposite directions;

a space being defined in one portion of the casing cover;

a cover piston being disposed within the space for movement back and forth with respect to an end surface of the rotor;

a plurality of air cylinders being mounted on the casing cover in a condition where piston rods thereof are connected with each other, and the cover piston is connected to a piston rod.

and having a piston rod, to which the cover piston is connected;

a lock bolt being coaxially provided on the air cylinder at the rearmost position, and the cover piston being connected to the piston rod of the air cylinder at the most front side;

a piston or a piston rod of the air cylinder at the rearmost position being in contact with the lock bolt for restricting movement of the cover piston by the lock bolt.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood more fully from the detailed description given hereinafter with reference to the accompanying drawings of the preferred embodiment of the present invention, which, however, should not be taken to be limitative to the present invention, but are for explanation and understanding only.

In the drawings:

Fig. 1 is a partially sectioned front elevation of one embodiment of a rotary pump according to the present invention;

Fig. 2 is a perspective view of the major part of the first embodiment of the rotary pump;

Fig. 3 is a longitudinally sectioned front elevation of another major part of the first embodiment of the rotary pump;

Fig. 4 is a longitudinally sectioned front elevation of another embodiment of the portion shown in Fig. 3;

Fig. 5 is a partially sectioned front elevation of another embodiment of the rotor according to the present invention;

Fig. 6 is a partially sectioned front elevation of slightly modification of the embodiment shown in Fig. 5;

Fig. 7 is a longitudinally sectioned front elevation showing operating condition of the major part of the embodiment shown in Fig. 5;

Fig. 8 is a longitudinally sectioned front elevation showing operating condition of the major part of the embodiment shown in Fig. 6;

Fig. 9 is a longitudinally sectioned front elevation showing operating condition of the major part of another embodiment shown in Fig. 6;

Fig. 10 is a partially sectioned front elevation of the conventional rotary pump; and

Fig. 11 is a side elevation of an internal mechanism.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention will be discussed hereinafter in detail in terms of the preferred embodiment of the present invention with reference to the accompanying drawings. In the following description, numerous specific details are set forth in order to provide a thorough understanding of the present invention. It will be obvious, however, to those skilled in the art that the present invention may be practiced without these specific details. In other instance, well-known structure are not shown in detail in order to avoid unnecessary obscurity of the present invention.

Fig. 1 shows one embodiment of a rotary pump according to the present invention. A construction of the rotary pump is basically the same as the prior art shown in Figs. 10 and 11. Namely, a pump casing 30 is constructed with a main casing 43 which define a concave pumping chamber 42 one the side of one end surface for housing a pair of rotors 31A and 31B (which will be identified by the reference numeral 31 as generally referred to) and loosely engage with pumping segments 32 which are integrally formed with the rotors 31A and 31B for rotation therein, and also defines a suction port 50 and a discharge port 51 communicated with the pumping chamber 42, and a casing cover 44 detachably mounted on the main casing 43 by bolts 52 in flush with the end surface of a pair of rotors 31.

It is similar to the prior art in that a pair of rotors 31 are mounted on hollow rotary drive shafts 34A and 34B (which will be identified by reference numeral 34 as generally referred to) by tightening rotor fastening bolt 36 into hollow portions 35 of the rotary drive shafts 34. However, particular mounting structure is differentiated from the prior art. As shown in Fig. 3, in accordance with the present invention, a through opening 53 formed with an internal

peripheral surface 46 with spline groove and a recessed portion 48 communicated with the through opening 53, having greater diameter that the through opening 53 and opening on the side of the casing cover 44 are formed in the rotors 31, respectively. Tip ends of a pair of hollow rotor drive shafts are formed as spline shafts 45 engaging with the spline of the inner periphery 46 of the through opening 53 so that the rotors 31 and the hollow rotary drive shafts 34 are integrated for rotation in accurately and coaxially aligned condition by engaging the spline shafts 45 with the through openings 53.

Then, the rotor fastening bolt 36 integrally formed with flange portion 47 which engages with the recessed portion 48 formed in the rotor 31, is inserted from the side of the casing cover 44. The rotor fastening bolt 36 is then inserted into the hollow portion 35 of the hollow rotor drive shaft 34 to extend a tip end thereof from an outer end surface of the hollow rotor drive shaft to be exposed therefrom. A fastening nut 49 is engaged with the exposed tip end of the rotor fastening bolt 36. By tightening the fastening nut 49 onto the rotor fastening bolt 36, the rotor 31 is drawn toward the hollow rotor drive shaft 34 to be fixed in a condition firmly abutting onto an inner end surface at a tip end of the hollow rotor drive shaft 34. It should be noted that in the condition where the flange 47 received within the recessed portion 48, the flange 47 and the rotor 31 form a flush surface mating with the casing cover 44. The fastening nut 49 may be replaced with a washer to engage the washer with the rotor fastening bolt 36 and a lock nut 57 is employed as the fastening nut so that the fastening nut 57 is engaged and tightened with the rotor fastening bolt 36 via the washer to achieve the similar effect, as a matter of course. In the alternative, a sealing member 72 such as an O ring is disposed between the flange portion 47 and the recessed portion 48 , and in conjunction therewith, the flange 47 and the rotor 31 form the flash surface to be mated with casing cover 44 in the condition where the flange 47 is engaged with the recessed portion 48, as shown in Fig. 3. In the drawings, the reference numerals 73 and 74 denote mechanical seals for maintaining between the pump chamber 42 and the outside in liquid tight state.

On the other hand, in the embodiment shown in Fig. 3, the rotor fastening bolt 36 is provided with the foregoing flange portion 47 on the tip end portion thereof to engage with the recessed portion 48 provided in the rotor 31. However, it is also possible to form the rotor fastening bolt 36 integrally with the rotor 31 to extend axially as shown in Fig. 4. With the embodiment shown in Fig. 4, since number of the parts can be reduced in comparison with the embodiment shown in Fig. 3, assembling can be facilitated. Furthermore, since the modification reduces portion to possibly retain the liquid to be further sanitary.

A pair of the hollow rotor drive shafts 34 (34A and 34B) are supported by bearings 55 and 56 in a gearbox 33 (housing 54) which is located adjacent the pump casing 30. Also, within the gearbox 33, gears 37 and 37 for synchronous driving are provided for respective of the hollow rotor drive shafts 34 so that the hollow rotor drive shafts 34A and 34B are synchronously driven for rotation in mutually opposite directions.

Among the foregoing hollow rotor drive shafts 34 (34A and 34B), one

hollow rotor drive shaft 34A is extended from the gearbox 33 in greater extent to form an extended drive shaft portion 39. On the extended drive shaft portion 39, a cylindrical frame shaped transmission coupling 42 which is important feature of the present invention, is connected.

Namely, as shown in Fig. 2, the transmission coupling 42 is formed with a cylindrical frame shaped coupling body 59 having a large operation window 58 on the circumference thereof, a boss hole projected on one end surface for connection, a connecting frame 62 for connecting a coupling 61 on the side of the other end portion of the transmission member, an operation window 63 and a connecting hole 64. After appropriately fitting a collar 65 to the extended drive shaft portion 39, the extended drive shaft 39 is engaged with the connecting boss hole 60 of the transmission coupling 41 to establish a key coupling with a key groove 66 and a key 67 provided between the extended drive shaft 39 and the transmission coupling 41. Furthermore, on a threaded portion 39a provided on the outer periphery of the extended drive shaft 39, a connecting nut 68 is engaged and tightened for coupling the extended drive shaft portion 39, and namely the hollow rotor drive shaft 34 with the transmission coupling 41 for integral rotation. On the other hand, a transmission member 69 connected on the side of the motor is connected to the transmission coupling 41 via the coupling on the side of the transmission member by bolt and nut 70, the connecting hole 64 of the connecting frame 62 engaged with the bolt and nut 70 and a buffering connecting member 71 engaged with the connecting hole 64. As can be clear from the discussion given hereabove, the foregoing fastening nut 49 and the lock nut 57 are tightened with the rotor fastening body 36 after mounting the transmission coupling 41,as a matter of course.

Upon driving the rotary pump constructed as set forth above, a rotational force of the transmission member 69 connected on the side of the motor is transmitted to the transmission coupling 41 via the coupling 61 on the side of the transmission member. The coupling 41 drives the hollow rotor drive shaft 34A on one side which is connected directly to the coupling 41, and drives the other hollow rotor drive shaft 34B via a pair of synchronous driving gears 37 and 38. By this, a pair of rotors 31 are synchronously rotated in mutually opposite directions.

During rotation of the rotors, since the main casing 43 and the casing cover 44 are firmly fitted with each other in face-to-face contact, the transported liquid may not be retained in this portion to keep the rotary motor in sanitary state. Upon disassembling, in the condition where the transmission coupling 41 is mounted on the hollow rotor drive shaft 34, an operator may insert a rotary tool, such as spanner, screw driver or the like into an operation space 40 through the operation window 58 or 63 to easily disengage the fastening nut 49 and the lock nut 57 which are engaged with the rotor fastening bolt 36 within the operation space 40. Then, by loosening the bolt and nut 20, the casing cover 44 is disassembled from the main casing 43. Thus, the rotor 31 and the rotor fastening bolt 36 as assembled or integrated as in the embodiment shown in Fig. 4 may be withdrawn to the outside of the main casing 43. Therefore, the pumping chamber 42 can be easily disassembled

for performing cleaning operation.

Upon assembling, the rotor drive shaft 34 is inserted into the through opening 53 in such a manner that the spline shaft 45 of the rotor drive shaft 34 is engaged with spline surface of the rotor 31. The rotor fastening bolt 36 is then inserted into the hollow portion 35 of the hollow rotor drive shaft 34 from the side of the casing cover 44. At the rear end portion, the operator tightens the fastening nut (washer) 49 and the lock nut 57 (fastening nut) onto the rotor fastening bolt 36 within the operation space 40 through the operation window 58 or 63. Thus, the rotary pump can be easily assembled.

With the foregoing embodiment, the spline shaft 45 at the tip end portion of the hollow rotor drive shaft is engaged with the spline surface on the inner periphery of the through opening 53 of the rotor 31, and the hollow rotor drive shaft 34 and the rotor 31 are rigidly secured with each other by the rotor fastening bolt 36. Therefore, slip will never be caused therebetween to assure integral rotation. Furthermore, concentric relationship between the rotor and the hollow rotor drive shaft can be maintained for a long period.

Figs. 5 to 9 show another embodiment of the rotary pump according to the present invention. It should be noted that, in the following disclosure, components common to the former embodiment of Figs. 1 to 4, will be identified by the same reference numerals, and detailed discussion for such common components will be omitted in order to avoid redundant discussion and whereby to keep the disclosure simple enough to facilitate clear understanding of the present invention. Therefore, the following disclosure will be concentrated to the particular construction of the shown embodiment.

As shown in Fig. 5, a space 80 having a given width in a thickness direction of a casing cover 44A is defined at the center portion of the casing cover 44A with the end surface 31a of the rotor 31 by forming a recess on the surface of the casing cover 44A mating with the end surface 31a of the rotor 31. A cover piston 81 is engaged with the peripheral wall defining the space 80 in gas tight fashion for reciprocal motion in the thickness direction, namely toward and away from the end surface 31a of the rotor 31. An air cylinder 82 is mounted on the casing cover 44A in coaxial relationship with the cover piston 81 by mounting bolts 83. The air cylinder 82 is constructed with a cylinder body 82a, a cylinder cover 86 located on the side of the casing cover 44A, a cylinder cover 87 on the opposite side, a piston 88 slidingly reciprocating within the cylinder body 82a, a piston rods 83a and 83b (which will be identified by reference numeral 83 as generally referred to) extending from both sides of the piston 88, and inlet and outlet ports and 92 communicated with forward drive side and reverse drive side cylinder chambers 89 and 90 defined on both sides of the piston 88. The cylinder cover 86 on the side of the casing cover 44A may be formed to be common with the casing cover 44A. Also, the cylinder cover 86 may be provided separately on the side of the air cylinder 82. In this case, the space 80 of the casing cover 44A is formed through the casing cover 44A. On the other hand, the cylinder cover 86 formed separately on the side of the air cylinder 82 may serve as the casing cover 44A and the cylinder cover 86 ands the casing cover may be formed integrally with each other. In this case, the cylinder cover 86 of the air cylinder is mounted directly on the main

casing 43 as the casing cover 44A by the bolts.

The end surface 81a on the side of the rotor 31 of the cover piston 8 is mated with the inner end surface 44a of the casing cover 44A for tight fitting with each other. On the other hand, the end surface 81a of the rotor 31 is substantially in contact with the end surface 31a of the rotor 31 with maintaining a fine gap therebetween. The piston rod 83a extended from the piston 88 of the air cylinder 82 toward the casing cover 44A is integrally connected to the cover piston 81 through the cylinder cover 86. The piston rod 83b projecting from the piston toward the opposite side is extended externally through the other cylinder cover 87. More accurately, the piston rod 83b is formed with a collar 94 engaging with a small diameter portion 93 and a nut 95 threadingly engaged with a thread portion at the tip end of the small diameter portion in order to secure the collar 94.

To the air cylinder 82, a lock cylinder 85 is coaxially mounted as shown in Fig. 5. To the lock cylinder 83, a lock bolt 84 is threadingly engaged, which lock bolt may abut against a tip end surface of the piston rod 83b of the air cylinder 82 and is movable back and forth along motion direction of the piston rod 83b. On the lock bolt 84, a lock nut 46 is threadingly engaged for locking the lock bolt 84 at a predetermined position. The lock cylinder 85 is not limited to the cylindrical shape but can be any appropriate shape. Namely, the lock cylinder is only required to be any appropriate shape of the frame body, to which the lock bolt 84 is threadingly engaged for linear motion in back and forth direction. On the other hand, while the shown embodiment employs the piston rod 83b of the air cylinder to extend outwardly through the cylinder cover 87, it is also possible to engage the lock bolt 84 with the cylinder chamber 89 from the cylinder cover 87 to abut the tip end portion of the lock bolt onto the piston 88 instead of providing the piston rod 83b.

Fig. 6 shows a modification of another embodiment of the rotary pump, in which shape of the cover piston 81A to be engaged with the space 80 in gas tight fashion. In the embodiment shown in Fig. 5, an end surface 81a at one side of the rotor of the cover piston 81. In contrast to this, the present invention shown in Fig. 6 has the cover piston 81A, in which a head portion 99a of the bolt 99is projected from the rotor 31. Therefore, a recessed portion 100 is provided for , in which a head portion 99a of the bolt 99is projected from the rotor 31. Therefore, a recessed portion 100 is provided for receiving the heat portion 99a of the bolt 99. In the shown construction of the rotary pump, a rotor drive shaft 117 is engaged at the center portion of the rotor 21 for mounting the rotor 31 on the rotor drive shaft 117. Across a stopper plate 101, the bolt 99 is threadingly engaged with the threaded hole 102 provided on the end surface of the rotor drive shaft 117. Thus, the rotor 31 is mounted on the rotor drive shaft.

Except for the shape of the color piston 81, the shown modification has the same construction as the former embodiment. The common components has been omitted from the detailed discussion in order to avoid redundant discussion and whereby to keep the disclosure simple enough to facilitate clear understanding of the present invention.

With the construction set forth above, upon operating the rotary pump in

the normal state, as shown in Fig. 5 or 6, an air is supplied into the forward side cylinder chamber 89 through the inlet port of the air cylinder 82 to whereby actuate the piston 88 in forward direction, namely toward left in the shown case. By this, the cover pistons 81 and 81A are placed in flush with the inner end surface of the casing cover 44A and substantially in contact with the pg\ea fine gap between the end surface 31a of the rotor 31. It should be noted when the piston 88 is moved toward left in the drawing, air in the left side reverse side cylinder chamber 90 is discharge out through the discharge port 92.

Upon automatic operation by the air cylinder 82, the lock bolt 84 of the lock cylinder 85 is retracted from the tip end surface of the piston rod 83b at the right side of the air cylinder 82 in the drawing. During operation of the rotary pump, the lock bolt 84 of the lock cylinder 85 may be kept in contact with the tip end surface of the piston rod 83 so as to prevent the cover pistons 81 and 81A from being retracted from the end surface 31a of the piston to reduce pumping effect even when the internal pressure of the pumping chamber 32 is elevated to be higher than or equal to a predetermined pressure to overcome the biasing force of the piston 88 of the air cylinder 82

Upon washing the pumping chamber 42 at the end of operation of the pump in a day, a griping portion of the lock bolt 42 is operated to retract the lock bolt 84from the tip end surface of the piston rod 83 and also, the air is introduced into the reverse side cylinder chamber 90 under pressure and the air in the cylinder chamber 89 on the opposite side is discharged through the discharge port 92, and in conjunction therewith the air in the space 80 defined by the casing cover 44 and the cover piston 81 is discharged through the air discharge opening 103. By this, as shown in Fig. 7 or Fig. 8, the piston 88 is moved toward right in the drawing. By this, the cover pistons 81 and 81A connected to the piston rod 83a is retracted away from the end surface 31a of the rotor 31 to define a large gap 104 between the cover piston 81 and 81A and the end surface of the rotor 31. By feeding the washing water into the pumping chamber 42, large amount of the washing water may flow as shown by arrow and discharged through the discharge port 51. Larger amount and higher flow velocity may result in higher washing effect to effectively improve washing effect for the pumping chamber 42, particularly the end surface 31a of the rotor 31 and the inner end surface 44a of the casing cover 44 opposing to the end surface 31a.

It should be noted that during washing operation, the rotor 31 may be rotated at low speed or held stopped. The washing water is preferable fed by a dedicated pump for the washing water. In this case, it is advantageous to make the bypass piping for feeding the washing water unnecessary in the rotary pump.

On the other hand, in case of manual operation, it may be possible not to use the air cylinder with maintaining the inlet and outlet port in free condition and use only lock cylinder to maintain the cover pistons 81 and 81A in flush with the casing cover 44 by the contact pressure for the piston rod 83b of only lock bolt 84. In this case, while the lock cylinder 85 is mounted on the casing cover 44 via the air cylinder 82, it is also possible to omit the air cylinder to

directly secure the lock cylinder 85 onto the casing cover 44 by means of bolts to abut the lock bolt 84 of the lock cylinder 85 to the portion projecting from the casing cover 44 (rod portion 83a).

Then, upon washing, the lock bolt 84 is retracted from the tip end surface of the piston rod 83b. At this condition, the washing water is fed into the pumping chamber to push the cover piston 81 away from the end surface 31a of the rotor 31 by the water pressure to form the large gap 104 therebetween to effectively flow large amount of washing waster to improve washing effect.

On the other hand, as set forth above, by retracting the lock bolt 84 of the lock cylinder 85 away from the tip end surface of the piston rod 83b on the right side of the air cylinder in the drawing, it becomes possible to provide vented (relief) cover function for the cover pistons 81 and 81A so that the pump discharge pressure of the rotary pump can be adjusted so as not to be elevated beyond a given pressure during automatic operation by the air cylinder.

Namely, by constantly supplying a given pressure of air through the inlet port 91 of the air cylinder 82, the cover pistons 81 and 81A are placed in opposition to the pumping action position of the end surface 31a of the rotor 31 by the piston 88 biased by the air pressure. When the discharge pressure of the pump is elevated beyond the given pressure to build up a pressure to retract the cover pistons 81 and 81A away from the end surface 31a of the rotor 31 overcoming the biasing pressure of the piston 88, the cover piston 81 is retracted from the end surface 31a of the rotor 31 to lower pumping function and relief the discharge pressure. By this, the discharge pressure of the rotary pump can be regulated. The discharge pressure can be freely set by the air pressure to be supplied into the air cylinder.

Fig. 9 shows a further embodiment of the rotary pump according to the present invention. In the former embodiment, only one air cylinder 82 is provided. In contrast to this, the shown embodiment is provided with another air cylinder 82A mounted by bolts 105, in addition to the air cylinder 82. Respective pistons 36 and 106 are connected to piston rod 108 extending through a common cylinder cover 107. The lock bolt 84 is threadingly engaged with the cylinder cover 109 of the later air cylinder 82. In the shown embodiment, two air cylinders 82 and 82A are connected with each other. However, more than two air cylinders may be employed. On the other hand, in the shown embodiment, the lock bolt 84 is threadingly engaged with the rearmost air cylinder 82A. However, it is also possible to mount the air cylinder 82A at the rearmost position, to threadingly engage the lock bolt 84 and to contact the lock bolt onto the piston or the piston rod as shown in Figs. 5 and 6.

In the shown embodiment, by introducing air from an inlet portion 110 of the later air cylinder 82A into the forward side cylinder chamber 111 under pressure, the air is supplied to the forward side cylinder 89 of another air cylinder through a through hole 111\2 provided in the piston rod 108 to push the pistons 88 and 106 of both air cylinders 82 and 82A simultaneously. Therefore, the cover pistons 81 and 81A are held by both pistons 88 and 106 to maintain the cover pistons 81 and 81A at the position opposing to the

pumping action position of the end surface 31a of the rotor 31 at greater force. At this time, as discussed above, the color piston 81 and 81A are held at predetermined action position by the lock bolt 84 as required. The reference numerals 113 and 114 denotes inlet and outlet ports provided in reverse side cylinder chambers 90 and 115 of both air cylinders 82 and 82A, and the reference numeral 116 may be a ventilation aperture provided in the space 80.

Although the present invention has been illustrated and described with respect to exemplary embodiments thereof, it should be understood by those skilled in the art that the foregoing and various changes, emission and additions may be made therein and thereto, without departing from the spirit and scope of the present invention. Therefore, the present invention should not be understood as limited to the specific embodiment set out above but to include all possible embodiments which can be embodied within a scope encompassed and equivalent thereof with respect to the feature set out in the appended claims.

WHAT IS CLAIMED IS:

1. A rotary pump comprising:

a pair of rotors having pumping segments mutually engaged with each other for synchronous revolution in mutually opposite direction within a pump casing;

a pair of hollowing rotor drive shafts supported in gearboxes adjacent said pump casing for integrally rotate with a pair of said rotors; and

a pair of rotor fastening bolts inserted into hollow portions of respective hollow rotor drive shafts to fix said pair of rotors and said pair of hollow rotor drive shafts on the outer end surfaces of said rotor drive shaft under tension,

respective of said hollow rotor drive shafts being synchronously rotated in mutually opposite direction with meshing with synchronous driving gears provided in respective gearboxes,

among both of said hollow rotor drive shafts, one of said hollow rotor drive shaft extends outwardly from said gearbox to form an extended drive shaft portion, a cylindrical frame form transmission coupling having an operation space for operating said rotor fastening bolt being coupled with said extended drive shaft portion for integral rotation.

2. A rotary pump as set forth in claim 1, wherein said pump casing comprises a main casing having a pumping chamber for receiving said pair of rotors and a casing cover flush with the end surfaces of said pair of rotors.

3. A rotary pump as set forth in claim 1, wherein said rotor and said hollow rotor drive shaft are connected by spline coupling for integral rotation, said rotor fastening bolt is inserted through said hollow rotor drive shaft through said rotor from the side of said casing cover, a flange provided on a end portion of said rotor fastening bolt is engaged within a recessed portion on the end surface of the rotor on the side of said casing cover.

4. A rotary pump as set forth in claim 1, wherein said rotor and said hollow rotor drive shaft are connected by spline coupling for integral rotation, said rotor fastening bolt is integrally formed with said rotor, and said rotor fastening bolt is inserted into said hollow rotor driven shaft.

5. A rotary pump as set forth in claim 3, wherein a fastening nut is threadingly engaged with said rotor fastening bolt extending through said hollow rotor drive shaft, at the outer end surface of said hollow rotor drive shaft.

6. A rotary pump as set forth in claim 4, wherein a fastening nut is threadingly engaged with said rotor fastening bolt extending through said hollow rotor drive shaft, at the outer end surface of said hollow rotor drive shaft.

7. A rotary pump as set forth in claim 1, wherein a bolt head to be abutted onto the outer end surface of said hollowing rotor drive shaft is provided on one end portion of said rotor fastening bolt inserted into said hollow rotor drive shaft, and a threaded portion to be threadingly engaged with a threaded hole

provided in said rotor is provided on the other end.

8. A rotary pump comprising:

a pair of rotors having pumping segments mutually engaged with each other for synchronous revolution in mutually opposite direction within a pump casing;

a pair of hollowing rotor drive shafts supported in gearboxes adjacent said pump casing for integrally rotate with a pair of said rotors; and

a pair of rotor fastening bolts inserted into hollow portions of respective hollow rotor drive shafts to fix said pair of rotors and said pair of hollow rotor drive shafts on the outer end surfaces of said rotor drive shaft under tension,

respective of said hollow rotor drive shafts being synchronously rotated in mutually opposite direction with meshing with synchronous driving gears provided in respective gearboxes,

said rotors and said hollow rotor drive shafts being connected by spline couplings for integral rotation,

said rotor fastening bolts being inserted through said hollow rotor drive shafts through said rotors from the side of said casing cover, and

a flange provided on a end portion of said rotor fastening bolt being engaged within a recessed portion on the end surface of the rotor on the side of said casing cover.

9. A rotary pump comprising:

a pair of rotors having pumping segments mutually engaged with each other for synchronous revolution in mutually opposite direction within a pump casing;

a pair of hollowing rotor drive shafts supported in gearboxes adjacent said pump casing for integrally rotate with a pair of said rotors; and

a pair of rotor fastening bolts inserted into hollow portions of respective hollow rotor drive shafts to fix said pair of rotors and said pair of hollow rotor drive shafts on the outer end surfaces of said rotor drive shaft under tension,

respective of said hollow rotor drive shafts being synchronously rotated in mutually opposite direction with meshing with synchronous driving gears provided in respective gearboxes,

said rotor and said hollow rotor drive shaft being connected by spline coupling for integral rotation,

said rotor fastening bolts being integrally formed with said rotors, and

said rotor fastening bolts being inserted into said hollow rotor driven shafts.

10. A rotary pump as set forth in claim 8, wherein, among both of said hollow rotor drive shafts, one of said hollow rotor drive shaft extends outwardly from said gearbox to form an extended drive shaft portion, a cylindrical frame form transmission coupling has an operation space for operating said rotor fastening bolt being coupled with said extended drive shaft portion for integral rotation.

11. A rotary pump as set forth in claim 9, wherein, among both of said hollow rotor drive shafts, one of said hollow rotor drive shaft extends outwardly from said gearbox to form an extended drive shaft portion, a cylindrical frame form transmission coupling has an operation space for operating said rotor fastening bolt being coupled with said extended drive shaft portion for integral rotation.

12. A rotary pump as set forth in claim 8, wherein said pump casing comprises a main casing having a pumping chamber for receiving said pair of rotors and a casing cover flush with the end surfaces of said pair of rotors.

13. A rotary pump as set forth in claim 9, wherein said pump casing comprises a main casing having a pumping chamber for receiving said pair of rotors and a casing cover flush with the end surfaces of said pair of rotors.

14. A rotary pump as set forth in claim 8, wherein a fastening nut is threadingly engaged with said rotor fastening bolt extending through said hollow rotor drive shaft, at the outer end surface of said hollow rotor drive shaft.

15. A rotary pump as set forth in claim 9, wherein a fastening nut is threadingly engaged with said rotor fastening bolt extending through said hollow rotor drive shaft, at the outer end surface of said hollow rotor drive shaft.

16. A rotary pump comprising:
a main casing;
a casing cover cooperated with said main casing for defining a pumping chamber therebetween;
a pair of rotors received within said pumping chamber with mutually meshing pumping segments for synchronous revolution in mutually opposite directions;
a space being defined in one portion of said casing cover;
a cover piston being disposed within said space for movement back and forth with respect to an end surface of said rotor;
an air cylinder being mounted on said casing cover and having a piston rod, to which said cover piston is connected.

17. A rotary pump comprising:
a main casing;
a casing cover cooperated with said main casing for defining a pumping chamber therebetween;
a pair of rotors received within said pumping chamber with mutually meshing pumping segments for synchronous revolution in mutually opposite directions;
a space being defined in one portion of said casing cover;
a cover piston being disposed within said space for movement back and forth with respect to an end surface of said rotor;
a lock cylinder having a lock bolt being mounted on said casing cover for

restricting movement of said cover piston by means of said lock bolt.

18. A rotary pump comprising:
a main casing;
a casing cover cooperated with said main casing for defining a pumping chamber therebetween;
a pair of rotors received within said pumping chamber with mutually meshing pumping segments for synchronous revolution in mutually opposite directions;
a space being defined in one portion of said casing cover;
a cover piston being disposed within said space for movement back and forth with respect to an end surface of said rotor;
an air cylinder being mounted on said casing cover and having a piston rod;
a lock cylinder having a lock bolt being mounted on said air cylinder;
said cover piston being connected to a piston rod projected from one end surface of said piston of said air cylinder;
a piston rod projecting from the other end surface of said piston of said air cylinder being abutted to said lock bolt for restricting movement of said cover piston by means of said lock bolt.

19. A rotary pump comprising:
a main casing;
a casing cover cooperated with said main casing for defining a pumping chamber therebetween;
a pair of rotors received within said pumping chamber with mutually meshing pumping segments for synchronous revolution in mutually opposite directions;
a space being defined in one portion of said casing cover;
a cover piston being disposed within said space for movement back and forth with respect to an end surface of said rotor;
a plurality of air cylinders being mounted on said casing cover in a condition where piston rods thereof are connected with each other, and said cover piston is connected to a piston rod.
and having a piston rod, to which said cover piston is connected.

20. A rotary pump comprising:
a main casing;
a casing cover cooperated with said main casing for defining a pumping chamber therebetween;
a pair of rotors received within said pumping chamber with mutually meshing pumping segments for synchronous revolution in mutually opposite directions;
a space being defined in one portion of said casing cover;
a cover piston being disposed within said space for movement back and forth with respect to an end surface of said rotor;

a plurality of air cylinders being mounted on said casing cover in a condition where piston rods thereof are connected with each other, and said cover piston is connected to a piston rod.
and having a piston rod, to which said cover piston is connected;

a lock bolt being coaxially provided on said air cylinder at the rearmost position, and said cover piston being connected to said piston rod of said air cylinder at the most front side;

a piston or a piston rod of said air cylinder at the rearmost position being in contact with said lock bolt for restricting movement of said cover piston by said lock bolt.

ABSTRACT OF THE DISCLOSURE

A rotary pump has a simple construction by omitting a transmission shaft on the side of a motor and whereby makes a cost of the rotary pump as low as possible, with maintaining feature that assembling and disassembling is facilitated. The rotary pump has a main casing, a casing cover cooperated with the main casing for defining a pumping chamber therebetween, a pair of rotors received within the pumping chamber with mutually meshing pumping segments for synchronous revolution in mutually opposite directions, a space being defined in one portion of the casing cover, a cover piston being disposed within the space for movement back and forth with respect to an end surface of the rotor, and an air cylinder being mounted on the casing cover and having a piston rod, to which the cover piston is connected.

FIG.1

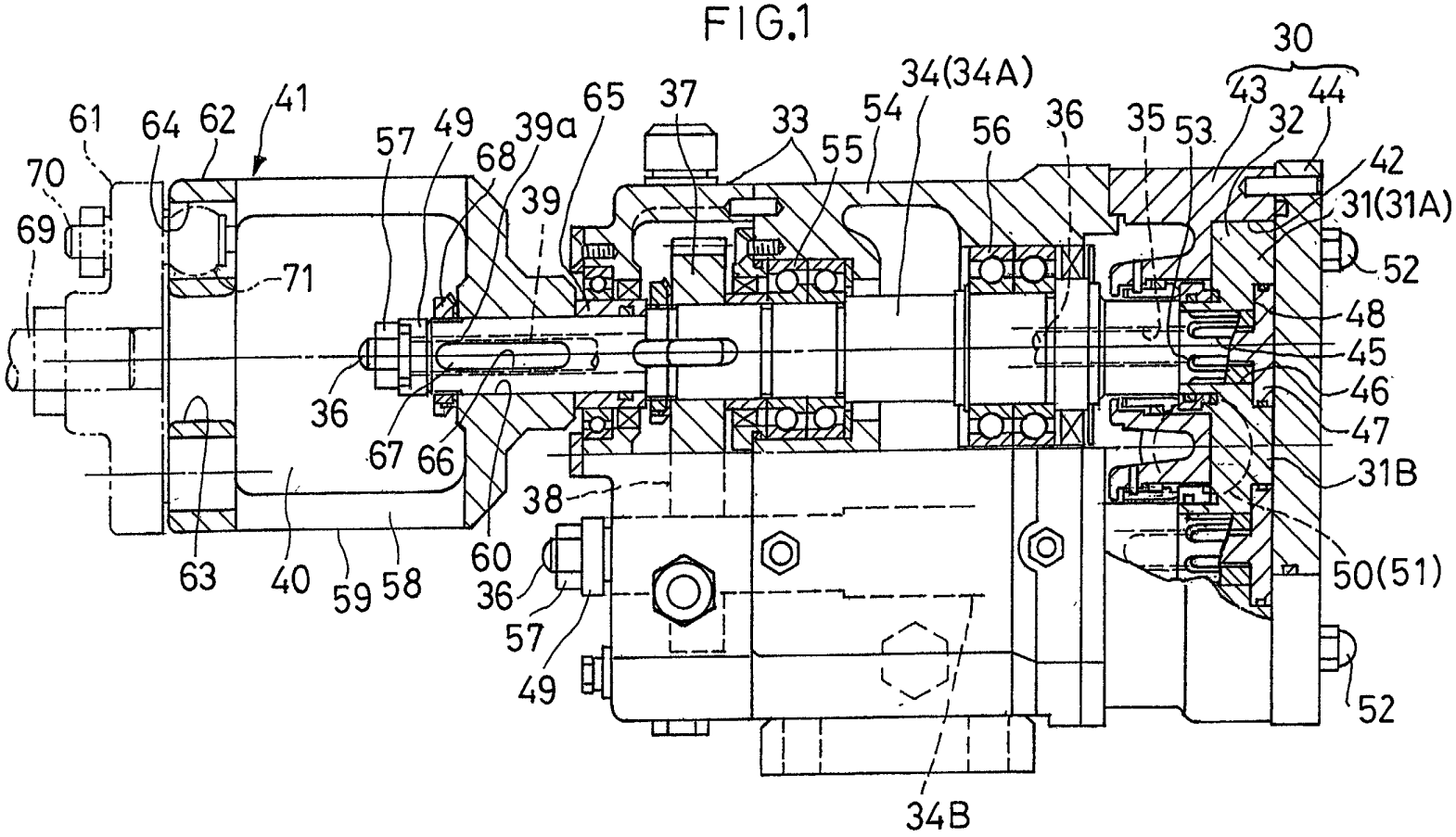
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FIG.2

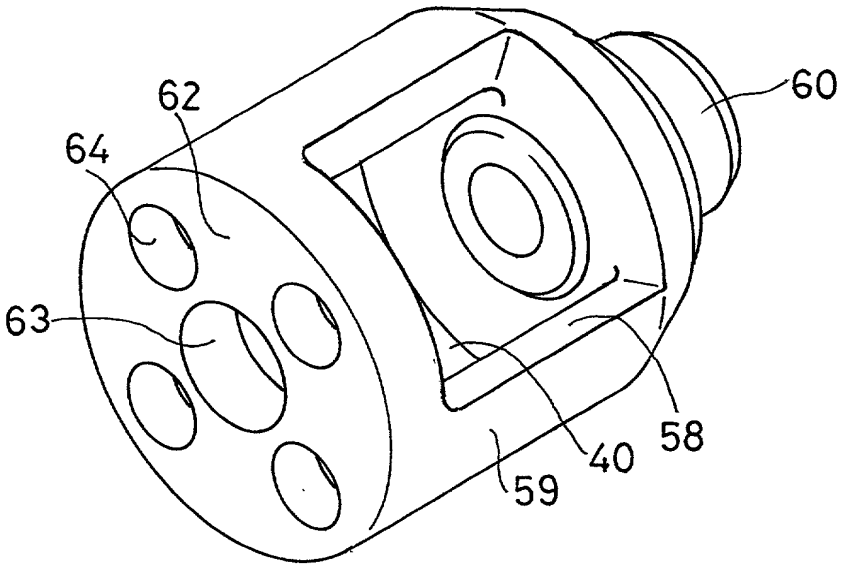

FIG.3

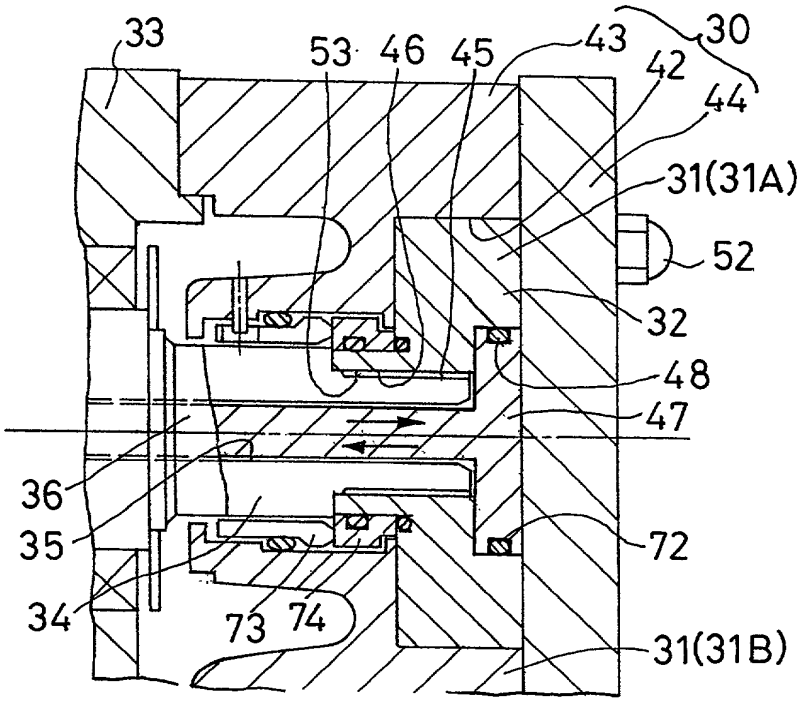
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FIG.4

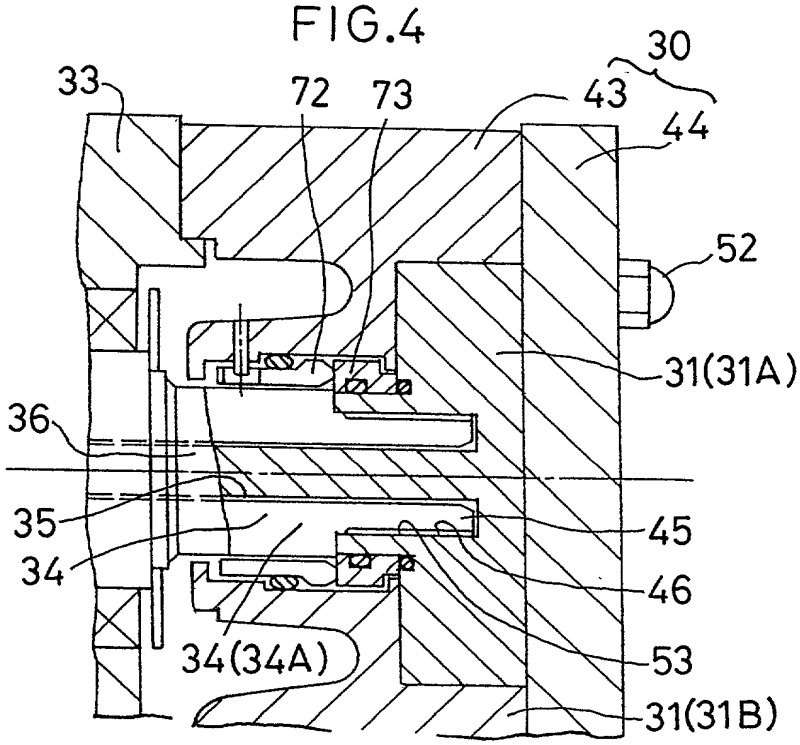
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FIG.5

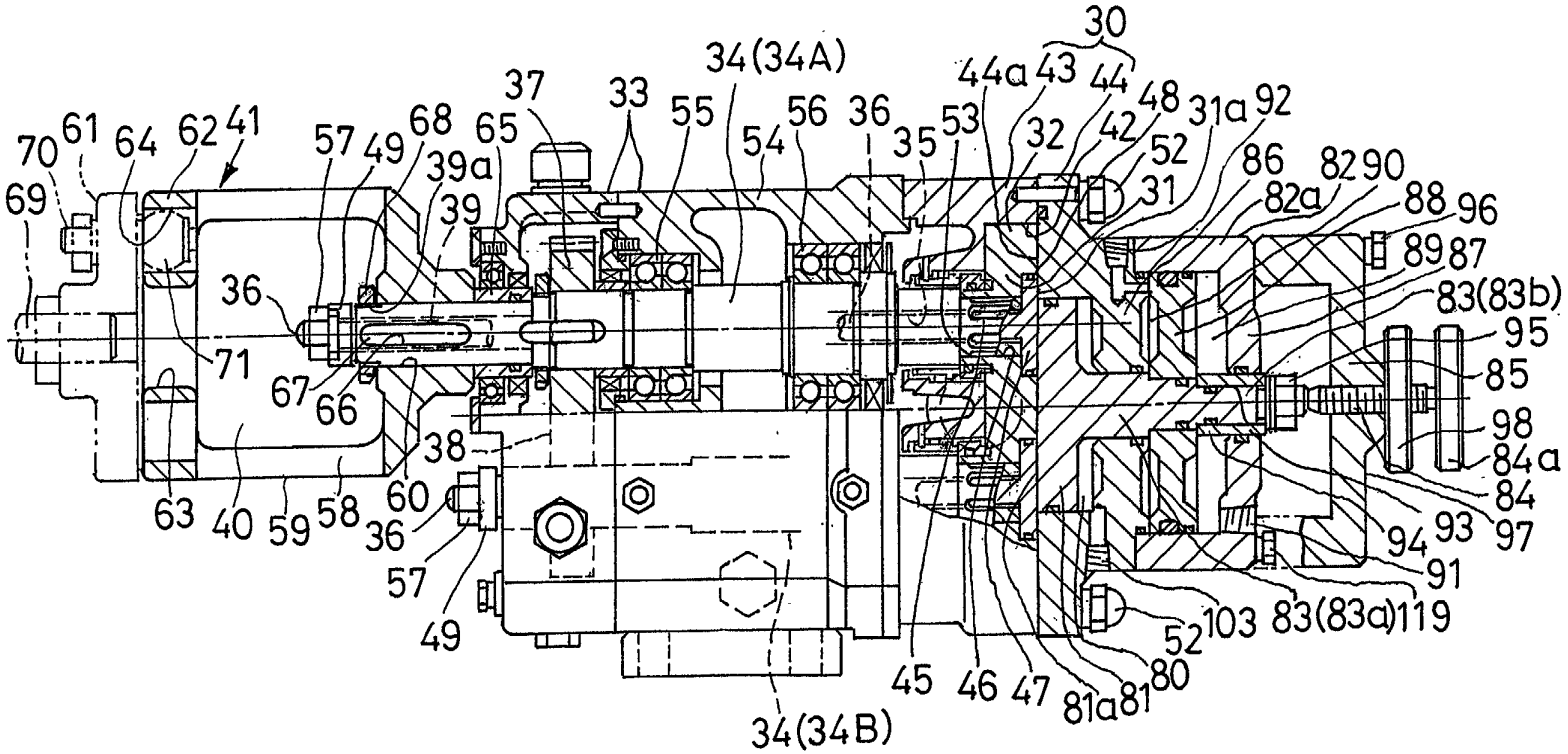


FIG.6

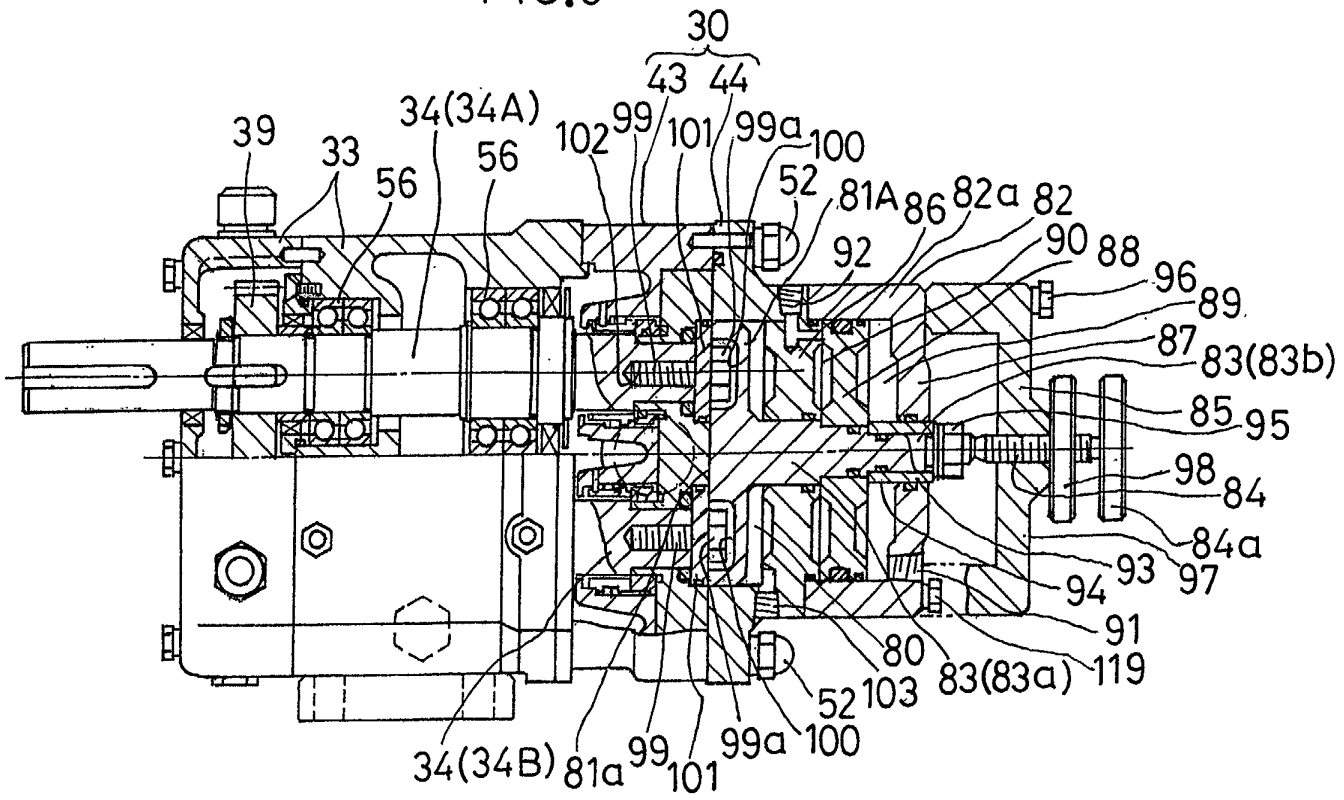
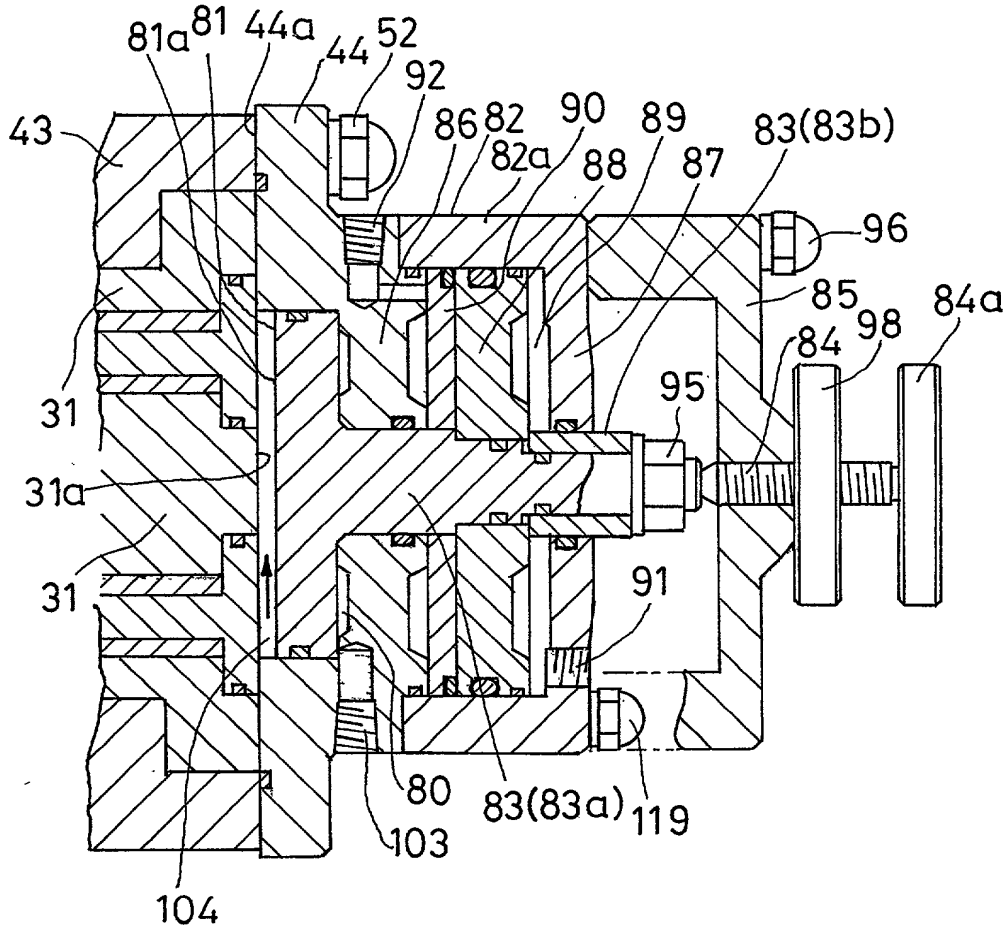


FIG.7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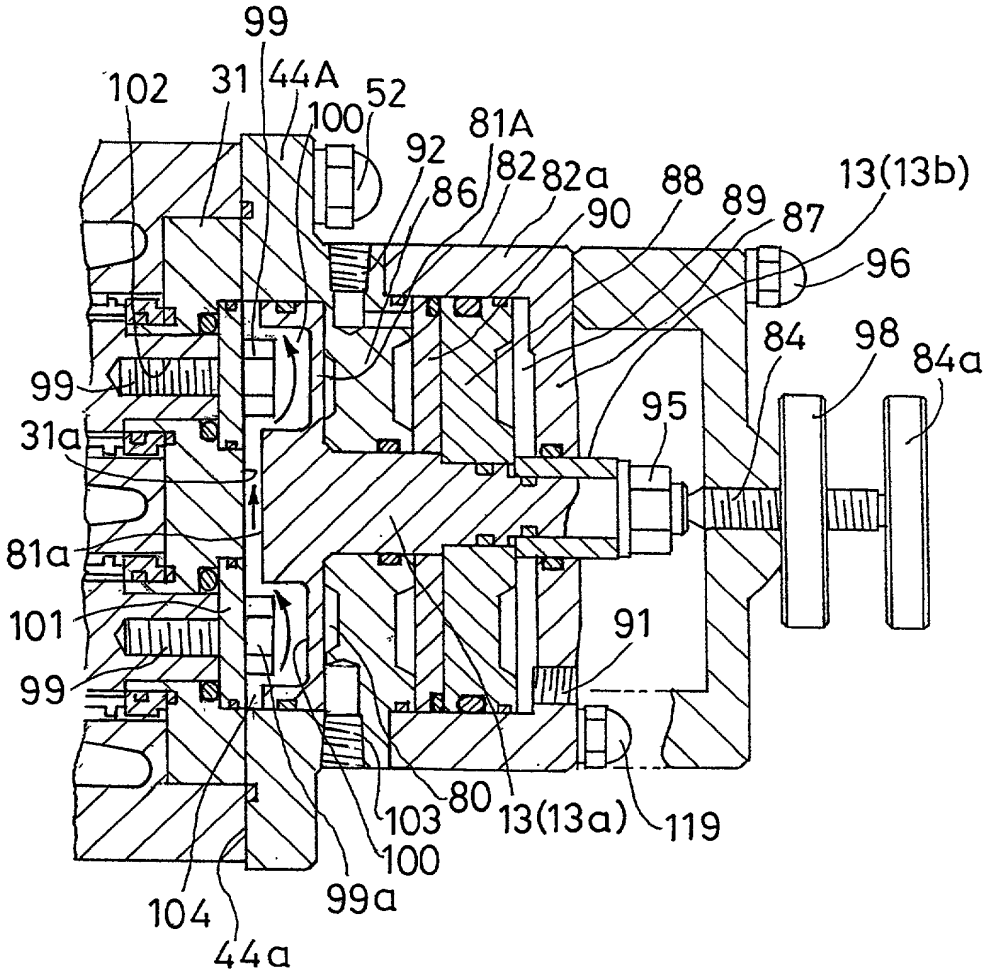
104

FIG.8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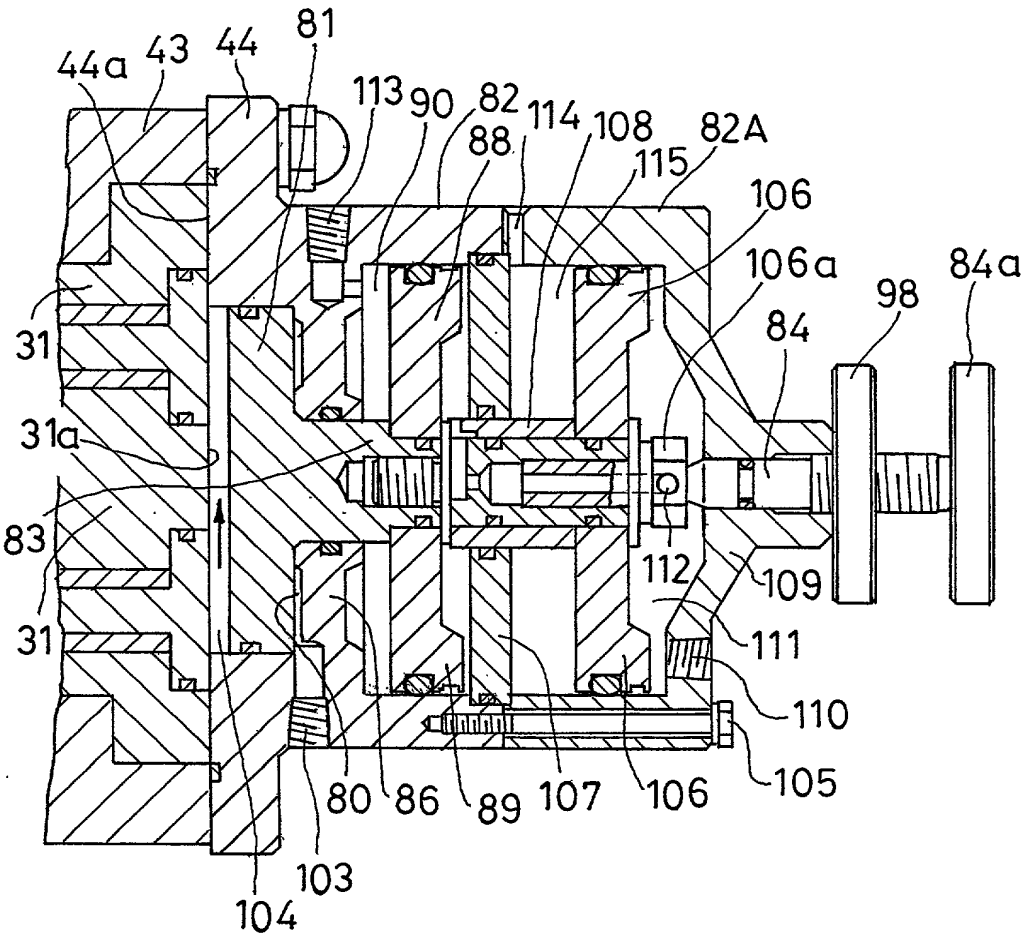
104
44a

FIG.9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104

FIG.10

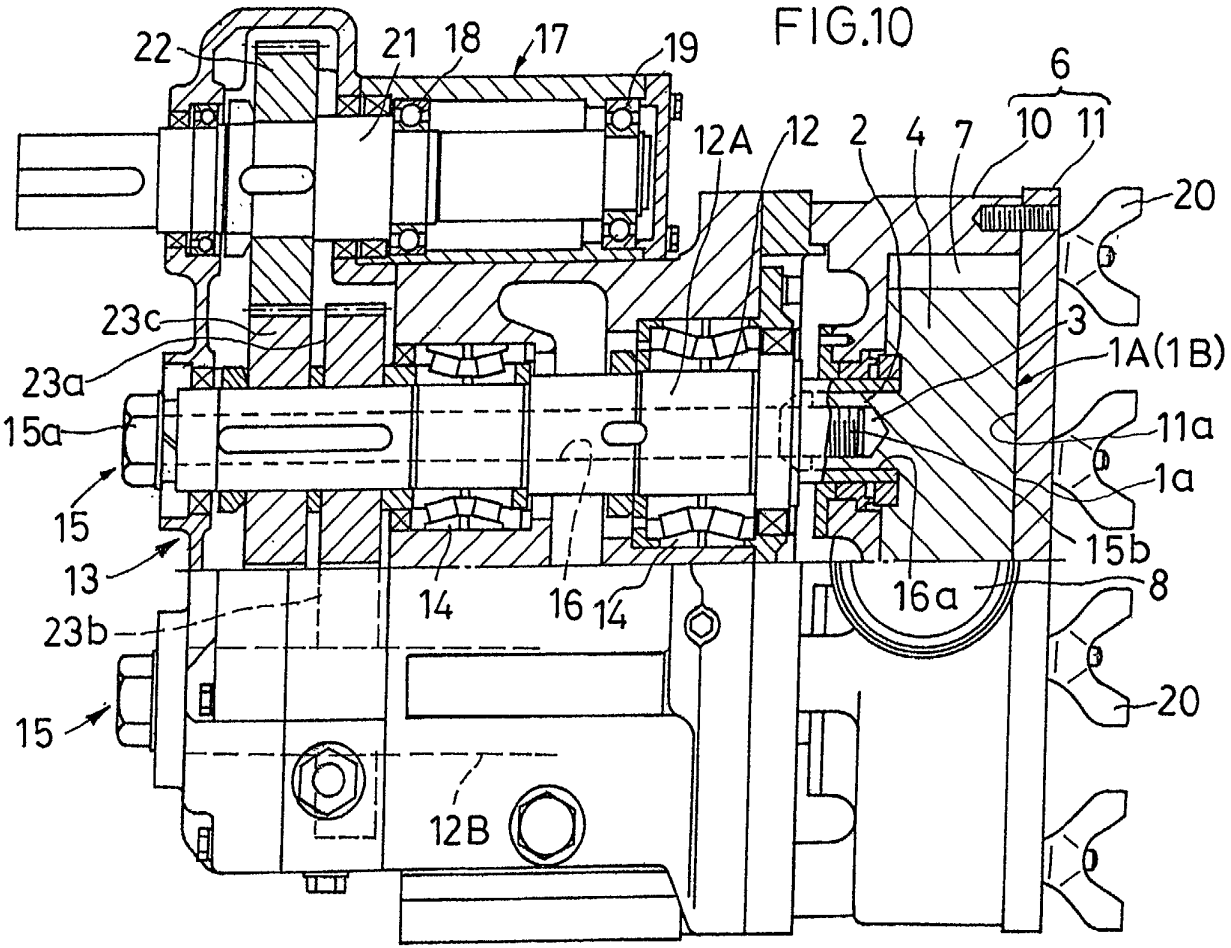
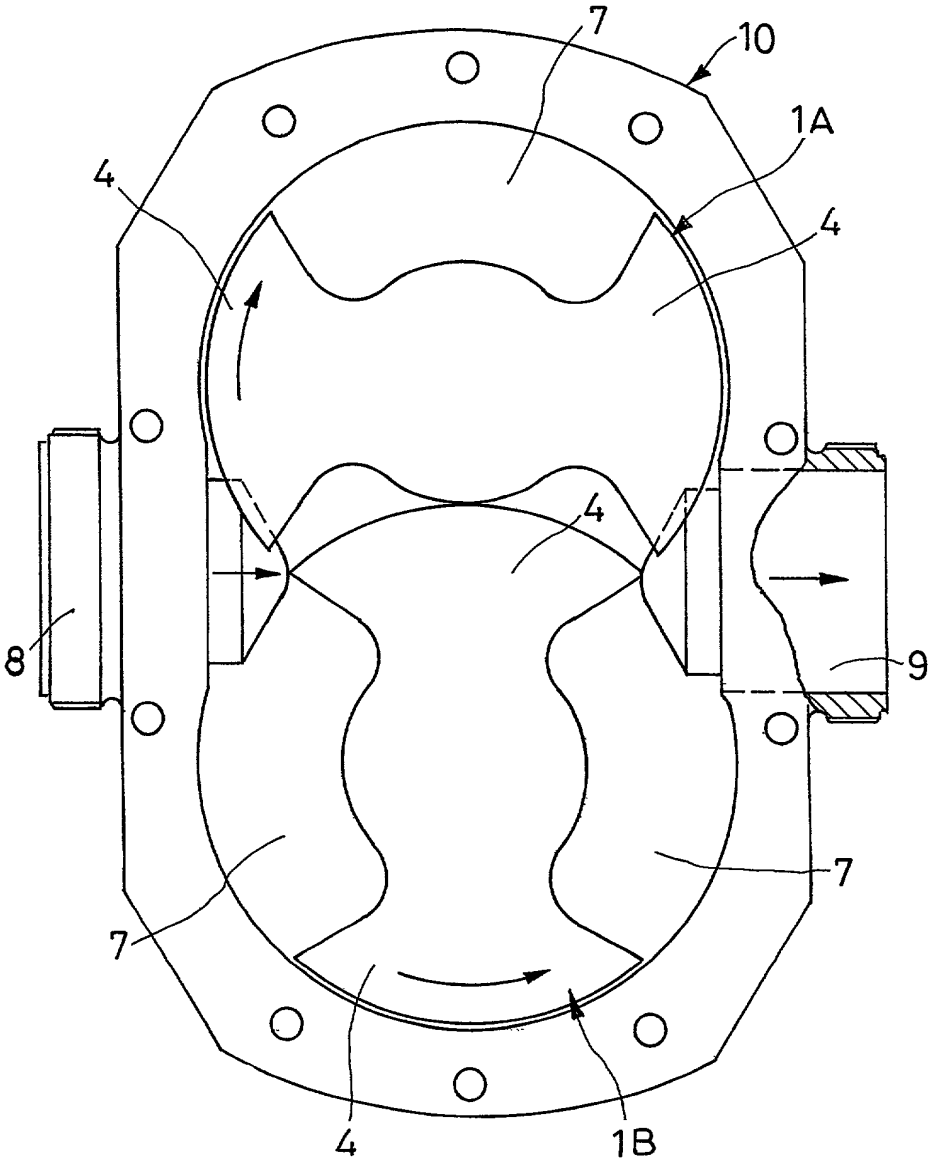


FIG.11



DECLARATION WITH POWER FOR U.S. PATENT APPLICATION **DOCKET NO. 673-** _____

(use additional sheet for more than two inventors)

I, the undersigned inventor hereby declare that my residence, post office address, and my citizenship are correctly stated below following my signature; that to the best of my knowledge I am the first, original and sole inventor (if only one signature appears below), or first original and joint inventor (if more signatures appear) of the invention described and claimed in the application for United States Letters Patent, having the title:

ROTARY PUMP

the description of which is enclosed herewith and I state that I reviewed and understand the contents of the enclosed specification and claims and recognize my obligation pursuant to 37 C.F.R. 1.56 to disclose all information that is material to the examination and prosecution of this patent application. I hereby state that I authorized the filing of this application.

I hereby claim the benefit of priority under 35 U.S.C. 119 of any foreign application(s) for patent or inventor's certificate identified below, and have also identified below any foreign application for patent or inventor's certificate for the same invention filed before that of the application(s) for which priority is claimed:

NUMBER	COUNTRY	FILING DATE (day/mo/yr)	PRIORITY CLAIMED
H11-101634	Japan	08/04/1999	YES [X] NO [ ]
H11-101635	Japan	08/04/1999	YES [X] NO [ ]
H11-101636	Japan	08/04/1999	YES [X] NO [ ]

I hereby appoint Fritz L. Schweitzer, Jr. Reg. No. 17,402; Michael A. Cornman, Reg. No. 20,672; Gabriel P. Katona, Reg. No. 20,829; Meyer A. Gross, Reg. No. 22,036; and Jay A. Bondell, Reg. No. 28,188 to prosecute this application and to transact all business in the U.S. Patent and Trademark Office connected therewith, and I hereby request that all correspondence herein be directed to Schweitzer Cornman & Gross, 230 Park Avenue, New York 10169; phone (212)986-3377; fax (212)986-6126.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Inventor Kazuo Morita Signature Kazuo Morita

Residence (city) Osaka-shi, Osaka, Japan Date March 20, 2000 ~~199~~

Postal address c/o NAKAKIN CO., LTD. of 1-21, Kikawahigashi 4-chome, Yodogawa-ku, Osaka-shi, Osaka, Japan Citizenship: Japanese

Inventor _____ Signature _____

Residence (city) _____ Japan Date _____, 199____

Postal address _____, Japan Citizenship: Japanese